ON THE STRATIGRAPHIC POSITION AND AGE OF THE JUDITH RIVER FORMATION

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PART II

THE STRATIGRAPHIC POSITION

Hayden, who was the first to note and study geologically the Judith River beds, and to whom the name is due, gives the first published section of them as he found them in the type region near the mouth of the Judith River, following it with a section of the marine strata (Fox Hills) immediately underlying them. Combining these two sections into one we have the following:[1]

HAYDEN'S SECTION OF JUDITH RIVER BEDS[2]

"Section of fresh water and estuary deposits at the mouth of the Judith River"

JUDITH RIVER FORMATION

TOP

	FEET
Yellow arenaceous marl passing downward into gray grit, with seams of impure lignite with *Ostrea subtrigonalis, Cyrena occidentalis, Melania convexa,* and *Paludina Conradi*.....	80
Impure lignite, containing much sand with Ostrea.....	10
Alternations of sand and clay with particles of lignite; also reddish argillaceous concretions with a few saurian teeth and fresh-water shells.....	80
Alternate strata of sand and clay, with impure lignite and silicified wood, in a good state of preservation.....	20

[1] *Trans. Amer. Phil. Soc.*, II, N.S., Philadelphia, 1860, pp. 129, 130.

[2] Hayden, according to his habit, constructed his general section from "a large number of local sections" "taken at different points." This is the only section of these beds ever published by him. The type locality is shown on the map (Pl. 8) opposite p. 154, in the area marked "B. L. (Badlands of the Judith)" overlooking the mouth of the Judith River, and is the only locality on the map so marked along the entire course of the Judith River.. Hence it must be considered the *type locality*. Professor F. B. Meek says that the Judith River Group was "first examined by him [Dr. F. V. Hayden] at the typical locality near the mouth of the Judith River on the upper Missouri River in Montana."—*U.S. Geol. Surv. Terr.*, IX, p. xlvii.

	FEET
Variable bed, consisting of alternations of sand and clay, with large concretions, with species of Melania, Paludina, Helix, Planorbis, Cyclas, Iguanodon, and Megalosaurus.....	100
Alternations of impure lignite and yellowish-brown clay with Unio, Paludina, Melania, Cyclas, and Lepidotus.....	25
Ferruginous sand and clay, having in the upper part a seam 3 or 4 inches in thickness composed mostly of shells of *Unio*. Lower part ferruginous and coarse gray grit with a seam near the base entirely composed of remains of *Unio Danai, U. Deweyanus, and U. subspatulatus*.....	100

FOX HILL'S FORMATION

Yellowish and reddish, rather coarse-grained sandstone, becoming deep red on exposure with *Inoceramus ventricosus*, *Mactra alta*, and *Cardium speciosum*.....	20–25
Mixed pure and impure lignite—whole bed containing many crystals of selenite and a yellowish substance like sulphur. The masses of lignite when broken reveal in considerable quantities small reddish crystalline fragments of a substance having the taste and appearance of rosin.....	6–8
Variable strata of drab clay, and gray sand and sandstone. Near the middle there are gray or ash-colored clays with very hard bluish-gray granular siliceous concertions with *Ostrea glabra, Hetangia americana, Panopea occidentalis*, and *Mactra formosa*.....	80–100

The table given on p. 642 gives the list of species collected by Hayden in the beds [Fox Hills] underlying the Judith River beds as identified by Professor F. B. Meek,[1] together with their outside distribution in other parts of Montana, the Dakotas, and Colorado. In the last column is shown the recurrence of these species in Stanton's Claggett formation, which apparently occupies the same position in relation to the Judith River beds, including without doubt the beds shown in Hayden's section, which are identical with the sandstones found by the writer at the top of the dark Pierre shales and below the lighter-colored clays, sands, and shales of Judith River age. In these lower sandstones invertebrate fossils of Fox Hills age were found.

[1] *Report U. S. Geol. Surv. Terr.*, IX (1876), 1–506.

Fox Hills Species from Mouth of Judith River (Immediately underlying Judith River Beds)	Distribution in Fox Hills of Other Localities				
	Wyoming near Parkman and in Converse County	North and South *Dakota* Mainly on Indian Reservations	*Colorado* Denver Basin and Eastern Colorado	*Colorado* Mainly on White River in North-Western Colorado	From Claggett Formation as described by Stanton (immediately underlying Judith River Beds)
Inoceramus pertenuis	..	..	..	×	..
Inoceramus crispii cubcompressa	..	..	..	..	..
Mytilus subarcuatus	..	..	×	..	..
Tancredia americana	×	×	×	..	×
Cardium (Cricocardium) speciosum	×	..	×	×	×
Callista (Dosiniopsis) Owenana	..	..	×	..	..
Tellina (Peronaea) equilateralis	×	..	×	..	..
Mactra (Cymbophora) formosa	..	..	×	..	×
Mactra (Cymbophora?) alta	..	..	×	×	..
Pholadomya subventricosa	..	..	..	..	×
Thracia subtortuosa	×	..	..	..	..
Thracia gracilis	..	..	×	..	×
Thracia (?) prouti	..	..	..	..	..
Liopistha (Cymella) undata	×	..	×	..	×
Glycimeris occidentalis	..	..	..	..	..
Lunatia subcrassa	×	×	×	..	×
Vanikoropsis Tuomeyana	..	..	..	..	×
Baculites asper	..	..	..	..	..

Stanton's Section on East Side of Cow Creek

		Feet
Judith River Beds	Middle portion covered in bed of creek. One hundred and fifty feet of lower Judith River beds are continuously exposed in the upper section, and one-half mile east, where the Judith River beds are horizontal, a thickness of 490 feet was measured, but the base is not exposed at this point. A shale bed about 30 feet above the base of the formation yielded many leaves of *Trapa (?) microphylla*, together with abundant fresh-water Mollusca, including *Sphaerium recticardinale. Physa copei (?), and Goniobasis subtortuosa.* Another horizon about 300 feet from the top, in the exposure one-half mile east of the section, yielded *Sphaerium planum, Anodonta propatoris, Unio danae (?), Unio primaevus, Valvata montanaensis, Hyalina? evansi, Hyalina(?) occidentalis, Planorbis amplexus, Physa copei Goniobasis subtortuosa*, and *Goniobasis gracilenta*	490

		FEET
Claggett Formation	*c*) Light-colored shales or sandy clays with band of brown sandstone containing *Tancredia americana* in middle. Top of marine	50
	b) Yellowish-brown sandstones, generally soft, but with harder layer and lenses, with *Tancredia americana, Cardium speciosum, Tellina equilateralis, Liopistha (Cymella) undata, Lunatia, subcrassa, Baculites* sp., and fragment of vertebrate jaw	20
	a) Dark shales with concretions bearing *Baculites ovatus, B. compressus, Nucula cancellata, Leda (Yoldia) evansi,* and *Gervillia borealis.* These shales weather much as the Bearpaw, but with a reddish tinge. The concretions are different with fewer fossils and not so great a variety. These beds become lighter toward the top, the upper 50 feet containing two seams of thin brown sandstone, each 2 to 3 feet thick	300–400
	Total thickness of Claggett	370–470
Eagle Formation No fossils	*e*) Cross-bedded and finely laminated sands with thin seams of lignites, in places becoming more massive	125
	d) Very light-colored, fine, heavy-bedded sandstone	40
	c) Heavy-bedded buff sandstones, soft at base, but harder above, and with indurated lenses and numerous large concretions, weathering brown at the top. The thickness of *b* and *c* is very variable	50
	b) Heavy-bedded buff sandstones with lenses of lignite and shales sometimes exhibiting cross-bedding	30
	a) Regularly-bedded buff sandstones with several thin seams of dark shales	20
	Total thickness of Eagle formation	265
Dark Benton Shales	Baculites and other invertebrates in concretions, and containing several layers of sandstones in upper 100 feet. The following fossils were found in these shales near the base: *Inoceramus* sp., fragments of a thick-shelled form; *Prionotropis(?)* sp., fragment; *Scaphites ventricosus; Baculites* sp., a slender, strongly nodose form. Several genera of invertebrates not specifically determinable were collected in the upper portion	300

The section by Stanton and Hatcher was made north of the Missouri in the disturbed region, but is apparently the normal section corresponding closely to those taken by us on the Judith River, at several places south of its mouth. As published, however, 500 to 700 feet of supposed Bearpaw shales, including light-colored sands and shales at the base, are added by Stanton above the Judith River beds. These have not been included by us as they were not in his section as shown one mile below their camp but were *added from exposures noted west of their camp.*[1] In some of his localities, as on the Birch Creek, he says:[2] "The overlying Bearpaw shales are not represented in this immediate region, having been entirely removed by erosion." In other places what *appear* to be Pierre shales seem to overlie the Judith and there is little doubt that in some cases they do actually occur at higher levels, as we saw at Mauland, but until a careful areal survey is made of the whole region it will be impossible to say whether the beds are below and of Belly River age, or whether the case is as at Mauland, where the cause of the apparent superposition is one of the numerous faults traversing the region. In Dr. Stanton's section given above there is no doubt but that 70 feet or more of the beds referred to the Claggett are of Fox Hills age, while the 300–400 feet of dark shale immediately below should be referred to the Pierre. These shales, Dr. Stanton says, "weather much as the Bearpaw" and contain concretions containing Pierre fossils. Stanton and Hatcher[3] say in their description of the Claggett:

> In the neighborhood of Judith (old Fort Claggett), where they are well exposed, they have a total thickness of about 400 feet and consist largely of dark clay shales with variable intercalated bands and beds of sandstone, especially in the upper half. The dark shales of the lower part of the formation contain many calcareous concretions, which yield *Gervillia borealis*, *Baculites ovatus*, *Baculites compressus*, and a few other forms, elsewhere regarded as characteristic of the Fort Pierre. The yellowish sandstone beds higher in the formation, especially one about 200 feet from the top and another near the summit, are often locally very fossiliferous, and bear an invertebrate fauna, of which the most conspicuous species are the following:

[1] *Bull. U.S. Geol. Surv., No. 257*, p. 44.

[2] *Ibid.*, p. 40.

[3] *Ibid.*, p. 13.

Species from Upper Part of Claggett Formation

Tancredia americana	Mactra formosa
Cardium speciosum	Mactra alta
Sphaeriola? endotrachys	Lunatia subcrassa
Tellina equilateralis	Vanikoropsis tuomeyana
Thracia gracilis	Baculites sp.
Liopistha (Cymella) undata	

This has long been considered a typical "Fox Hills" fauna, and a number of its species do recur at the top of the marine Cretaceous immediately below the Laramie in Colorado and elsewhere.

The table already given of the Fox Hills fauna lying below the Judith River contains a list of 18 species of which four, so far as the writer can learn, have not yet been found elsewhere in the Fox Hills. Out of the remaining 14, 10 have been collected in the Fox Hills beds of eastern Colorado, while 8 have been found in the Claggett of Stanton, which seems not only to contain a "typical Fox Hills" fauna but also to hold the same stratigraphic position. The Fox Hills beds of Canada occupy the same position also, but they are, according to Dawson, McConnell, and Tyrrell, so inconstant that they have been considered as a whole with the Pierre and the two faunas have not been differentiated.[1] This inconstancy of the Fox Hills beds, especially so far as thickness goes, has also been everywhere noted south of the international boundary line, ranging from nothing (that is, in some places the overlying beds—Lance and Judith River—rest on the Pierre shales) to 800 or 1,000 feet. This last is the thickness in the Denver basin of Colorado as given by Eldridge.[2] In one place only, in Colorado, does it fall much below 1,000 feet. This is at Golden, where the thickness is only 500 feet, which Eldridge attributes to the non-deposition of the lower part. This thickness of 500 feet is about the same as noted by us in 1910 in south-central Wyoming. As to the shells in this Colorado section Eldridge says:[3]

While the invertebrate fossil remains occur throughout the entire thickness of the Fox Hills, there is an especially conspicuous array of characteristic forms at the very summit of the formation, in the uppermost layer of the capping sandstone, none of which is ever found above, and but few of which are met with in numbers below.

[1] *Contribution to Canadian Paleontology*, I, 29.

[2] *Monographs U.S. Geol. Surv.*, XXVII (1896), 71. [3] *Ibid.*, p. 72.

In the table already given, of the species listed in the column under "Denver Basin and Eastern Colorado," more than half the number came from the very summit of the formation where there is no admixture of Pierre forms. Curiously enough, too, the list for the beds below the Judith River in Dr. Stanton's section on east side of Cow Creek (see pp. 642–43) suggests no mingling of Pierre and Fox Hills forms, such as is so clearly shown in the collections made on the Yellowstone River about 150 miles above its mouth.[1] Whether this indicates a condition in the Judith basin similar to that noted by Eldridge at Golden will have to be left to the result of future careful study of the Fox Hills outcrops. It is more than likely, however, that, as stated by Professor Meek:[2] "These beds underlying the brackish-water lignite [Judith River] beds form an upper member of the Fox Hills group."

The mingling of the Fox Hills and Pierre faunas has been noted, but to a more limited extent, also in the Dakotas where, however, as we have indicated, the entire thickness of the Fox Hills is not seen. Indeed, it is questionable whether a full development of the formation occurs anywhere in this area. At the top of the Fox Hills sandstone, which has a marine fauna, Dr. Stanton found a thin and widely distributed bed with a brackish-water fauna which he regards as belonging to the Fox Hills rather than to the overlying Lance formation, an interpretation that is not in accord with the views of the field geologists studying the area, who placed it immediately above the unconformity which marks the contact of the Lance on the Fox Hills.[3] Similar brackish-water faunas are found, according to Dr. Stanton, wherever the Judith River formation is found "intercalated in the upper and lower portions of the formation."[4] This occurrence, just referred to as at the base of the Lance formation, is on the line of the unconformity which,

[1] *Report U.S. Geol Surv. Terr.*, IX (1876), p. xxxiv.

[2] *Ibid.*, p. xxxvi.

[3] *Amer. Jour. Sci.*, XXX (September, 1910), 178.

[4] *Bull. U.S. Geol. Surv., No. 257*, p. 120.

The entire quotation is: "The brackish fauna has a wide geographic distribution occurring in practically every area in which the Judith River formation is found, but it is confined to thin beds intercalated in the upper and lower portions of the formation."

according to Knowlton,[1] is so widely recognizable. Referring to this mingling of forms at the base of the Lance, Knowlton says:[2]

> Because Fox Hills fossils occur in the lignitic shales at the base of the "somber beds" and mingled with the brackish-water types of the Lance formation is not necessarily proof positive that the various faunas lived at the same time; for if the deposition of the Fox Hills was followed by a definite erosion interval, what is more probable than that in the deposition of succeeding strata fossil shells would be eroded from the marine beds and carried into channels, there to mingle with the then living brackish-water fauna of the Lance formation?

A reference, at this point, to the Canadian section will be of interest as proving the existence of two series of fresh-water beds, the lower one of which was named the Belly River series by Dr. G. M. Dawson in 1882.[3] He had previously described in his report on the geology and resources[4] in the vicinity of the 49th parallel an upper series of fresh-water badland beds lying south of Wood Mountain, which he referred to the Lignite Tertiary and an underlying series thought to correspond to the Fox Hills group.[5] By the Lignite Tertiary, Dawson meant the Fort Union group of Hayden; and he also correlated the beds with the Judith River beds. The same beds are later described as the Laramie (Edmonton and Paskapoo) by the other Canadian geologists.

Later in his last report,[6] without having revisited the region south of Wood Mountain, Dawson relegated these beds to the Belly River series, and says: "The beds thus separated as the Belly River series were, in 1875, by me, correlated with the Judith River series of the Missouri." Dawson had evidently been misled by the lithological resemblance between the two series. On p. 117*c* of the report just cited he says: "The Belly River series has

[1] *Proc. Wash. Acad. Sci.*, XI (1909), 170–238;. *Jour. Geol.*, XIX (1911), 360–776.

[2] *Ibid.*, p. 365.

[3] *Geol. Surv. Canada, Report for 1880–82*, Montreal, 1883, pp. 1B–8B. On p. 1 reference is made to a note published by Dawson in May, 1882, in which he says "the following report is essentially a reprint."

[4] *British North American Boundary Commission Report on the Geology and Resources in the Region in the Vicinity of the 49th Parallel*, Montreal, 1875, pp. 103–58.

[5] *Ibid.*, p. 156.

[6] *Geol. Surv. Canada, Report of Progress, 1882–84*, Montreal, 1885, "Report of the Region in the Vicinity of Bow and Belly Rivers, 1884," pp. 118*c* f.

not yet been definitely identified in any part of the disturbed belt bordering the mountains, where, from the complicated character of the sections and absence of fossils, it is difficult to discriminate between it and the lithologically similar beds of the Laramie." By Laramie, Dawson meant the beds which overlie the Fox Hills Cretaceous, including his Porcupine Hills and St. Mary's series, or, as the Canadians name them later, "Paskapoo" and "Edmonton." As Dawson says,[1] it is not intended by its [Laramie] use to differentiate the beds so named from those of the Judith River and Fort Union series, with which they may be found to blend as the intervening district is more completely explored. That Dawson was not himself satisfied is shown by the fact that in the same report, pp. 125, 126, he suggests an alternative explanation which involves the existence of an unconformity at the base of the Judith River formation. The evident confusion in trying to differentiate between these "Laramie" beds (Dawson) and the Belly River beds was not cleared up until more complete stratigraphic examinations were made by R. G. McConnell[2] and J. B. Tyrrell.[3]

McConnell, when considering the stratigraphical position of the Belly River beds, writes as follows:[4]

> The doubt which existed at one time in regard to the stratigraphical position of the Belly River series, on account of the Laramie *facies* of its invertebrate fauna, has been removed by a more complete examination of its eastern margin. Its line of contact with the Pierre has now been traced, through a distance of over 150 miles, by numerous exposures, all of which afforded the clearest possible proof of its subordinate position. The junction is marked in many places by low plateaus (see p. 41), which offer exceptional facilities for noting the relations of the two formations, as they owe their origin directly to the superposition of a protecting covering of the less easily eroded dark shales on the light-colored beds below. The western slopes of these plateaus are usually bare, and the line of contact between the two dissimilarly colored series distinctly drawn. A reference to the general section which accompanies the map will also show that at the west end of the Cypress Hills, the Laramie and Belly River series, separated by the Pierre shales, occur in what is practically the same section, and as the beds have been so little disturbed that their maximum dip seldom exceeds ten feet to the mile, and consequently no question of over-

[1] *Geol. Surv. Canada, Report for 1880–82*, Montreal, 1883, p. 2B.

[2] *Geol. Surv. Canada*, I, "Report for 1885," Montreal, pp. 1–85*c*.

[3] *Ibid.*, II, "Report for 1886," Montreal, pp. 1–176*e*.

[4] *Ibid.*, p. 64*c*.

turn or dislocation is involved, no better stratigraphical evidence can possibly be offered.[1]

Tyrrell's work in 1886[2] was in the northern part of Alberta and the western edge of both Assiniboia and Saskatchewan on drainage tributary to Red Deer River, Ghost River, Bow River, and both the North and South Saskatchewan. His section in this area from the Belly River series to the Laramie, including both, is as follows:

	FEET
Laramie	
Paskapoo Series: Gray and brownish weathering, lamellar or massive sandstones, and olive sandy shales. This is an exclusively fresh-water deposit.....	5,700
Edmonton Series: Soft whitish sandstones and white or gray, often arenaceous, clays, with bands and nodules of clay, ironstone, and numerous seams of lignite. These are of brackish-water origin and correspond to the lowest portion of the St. Mary River series of Dr. Dawson's Report (*Geol. Survey Report for 1882–84*, p. 114*c*)	700
Fox Hills and Pierre	
Brownish weathering sandstones and dark gray clay shales	600
Belly River Series	
Soft, whitish sandstones and arenaceous clays, changing toward the east to light-brownish and yellowish sandstones and sandy shales, bottom not seen.....	

From what we have detailed in the preceding pages, it seems impossible to avoid the conclusion that the stratigraphic position of the Judith River beds is *above* the Fox Hills sandstone which in turn rests on the Pierre shales. The Judith River thus holds exactly the same interval in the geological column that is occupied by the Lance formation and not that of the Belly River series of Canada, nor that noted for their equivalent beds in the United States. The lithological resemblance between the beds of the Belly River series and the Judith River formation does not count for much and is no greater than that between the Lance formation and the Judith River beds. Dr. Stanton,[3] referring to the Belly River series, says:

[1] Mr. McConnell in reply to an inquiry makes the following statement to the writer: "I have had no reason to change my mind in regard to the relative positions of the Belly River and Pierre formations as given in the report you refer to. I have not done any work in recent years on the plains, but the work done by others of the Survey has all been confirmatory."

[2] *Geol. Surv. Canada*, II, "Report for 1886," Montreal, p. 5*e*.

[3] *Bull. U.S. Geol. Surv., No. 257*, p. 26.

R. G. McConnell and J. B. Tyrrell confirmed Dr. Dawson's conclusions concerning the stratigraphic position of the Belly River series so far as the overlying beds were concerned but still left the exact age of the underlying formation undetermined.

They could hardly have done otherwise as their sections in both cases did not go to the base of the Belly River series, but in the Saskatchewan and Peace River districts Benton shales[1] were found by Dr. G. M. Dawson below the Niobrara, to which latter formation Dawson and the other Canadian geologists referred the beds afterward relegated to the Belly River series. It was here that the Dunvegan sandstones, which lie above the Benton, were named; and these Dunvegan sandstones Dawson was always inclined to correlate with the Belly River series. The flora of this Dunvegan series, which Sir William Dawson says is very nearly akin to that of the Dakota group, "accords with the stratigraphical position assigned the beds, namely below the horizon of the Fort Pierre Cretaceous."[2] The following section is given by Osborne on p. 9, in Vol. III, Part II, of *Contributions to Canadian Paleontology:*

PROVISIONAL CORRELATION

Fresh water	Paskapoo* (no dinosaurs)	Ft. Union†	
Brackish and fresh water	Edmonton	Laramie and Judith River	Triceratops, Torosaurus, Dryptosaurus, Ornithomimus
Marine	Pierre-Fox Hills Group	Fox Hills Fort Pierre	
Fresh and brackish water	Belly River	Montana exposures in part	Stereocephalus, Monoclonius, Ceratops, Trachodon, Deinodon, Ornithomimus, Compsemys, Ptilodus
Sandy clays and sandstones	910 feet	(Niobrara)	
	Ft. Benton	Ft. Benton Dakota	

* Regarded by Tyrrell as the beginning of the Tertiary.

† Mammals of Puerco type discovered by Douglas in 1901.

[1] *Geol. Surv. Canada, 1879–80*, Montreal, 1881, p. 133B.

[2] *Ibid.*, pp. 119–23B.

There is, therefore, little, or no doubt as to the beds underlying the Belly River series in Canada. On our side of the line, we were fortunate enough to see complete sections from the Jurassic up into the Fort Union on Fish Creek, where the Belly River beds lie above the Eagle sandstones with an intervening alternation of sandstones and sandy shales that could not in any way be confounded with the characteristic soft dark shales of the Pierre that rest on the horizontal fresh-water badland bed of Belly River age.

COMPARATIVE SECTIONS SHOWING RELATIVE POSITION OF BELLY RIVER AND JUDITH RIVER FORMATIONS

		Colorado and Wyoming		Montana			Canada
		Eastern Colorado	Wyoming	Judith River Section	Fish Creek Section	Willow Creek Section	
Eocene Tertiary	Ft. Union		Upper Fort Union		Fort Union	Fort Union	Paskapoo
			Lower Fort Union (Lance)	Judith River	Lance	Lance	Edmonton
	Shoshone	Denver			Livingston	Absent	
		Arapahoe					
Upper Cret.	Lara.	Laramie	Laramie	Absent	Absent	Absent	Absent
	Mont.	Fox Hills	Fox Hills	Fox Hills	Fox Hills	Absent	Fox Hills
		Pierre	Pierre	Pierre	Pierre	Pierre	Pierre
Middle Cret.	Colo.	Niobrara	?	Belly River Eagle	Belly River Eagle	Belly River Eagle	Belly River Dunvegan
		Benton	Benton	Benton	Benton	Benton	Benton
	Dak.	Dakota	Dakota?				Dakota?
Lower Cret.		Comanche		Kootenai	Kootenai?		Kootenai
		Morrison		Morrison	Morrison		

In the accompanying correlation table of local sections the line of unconformity between the Cretaceous and Tertiary is shown by the double line, which, in Colorado, indicates the break between the Arapahoe and the Laramie, and in other localities represents the erosional interval between the Lance and Laramie wherever the two are in contact as seen by Dr. Knowlton and the writer on the North Platte River near the mouth of Medicine Bow River in Wyoming. It marks also the greater stratigraphic hiatus noted in all sections made up to the present time in Montana where the Laramie is absent; and where either the Lance or the Judith River is in contact with the Fox Hills or where this also is absent with the Pierre, all of these conditions are shown graphically in this section. The sections in the Dakotas are not given, but there, as already stated, the Lance is sometimes in direct contact with the Pierre, as in the section given for Willow Creek, Mont., or with the FoxHills beds, the thickness of which varies according to the amount that has been removed by erosion. This need only be referred to here, as the whole subject has been thoroughly treated by Dr. Knowlton in his two papers on the stratigraphic position of the Lance formation.[1] It is necessary to state here only that the writer is in perfect agreement with Dr. Knowlton[2] as to the position of this unconformity and its being the place at which to draw the line between the Cretaceous and Tertiary, and further, to reiterate that the Judith River formation is the direct equivalent of the Lance formation, not only from its paleontological contents, as will be shown later, but also from its stratigraphic position as shown in the section given above.

[1] *Proc. Wash. Acad. Sci.*, XI (1909), 179–238; *Jour. Geol.*, XIX, No. 4 (May-June, 1911), pp. 358–76.

[2] *Jour. Geol.*, XIX, No. 4 (May-June, 1911), p. 376.